A REPORT ON THE TROPHIC STATUS OF

BETULA LAKE

WHITESHELL PROVINCIAL PARK

(1978 - 1982)

By

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INTRODUCTION

The Public Participation Program was initiated in 1978 in response to requests for water quality information by concerned cottage owners on many of the recreational lakes in Manitoba. Previous studies have shown that the enrichment (trophic) status of a lake can be estimated by the use of Secchi disc readings (transparency) and chlorophyll a concentrations (the green pigment in algae) which indicate water clarity and algal densities, respectively. The determination of the trophic status of lakes is vital to the classification of those lakes for management purposes, restoration, protection and site specific monitoring.

Volunteers are supplied with sampling kits which include a Secchi disc, a composite water sampler, one litre bottles, magnesium carbonate preservative and instructions. Participants are requested to take weekly Secchi disc measurements and samples during the ice free period of the year. Water samples are preserved and shipped to the Technical Services Laboratory in Winnipeg, where they are analyzed for chlorophyll a. Analyses of the chlorophyll a and Secchi disc results reveal the relative trophic status of each lake. Long term sampling over a number of years is useful in the detection of trends related to nutrient enrichment.

It is essential that a sampling program on a lake be continued over a period of five to ten years in order to determine if there is a trend toward accelerated enrichment. In many lakes, temporary degradation of water quality occurs during periods of extensive algal blooms. The fluctuation in algal populations occurs both seasonally and from year to year, and is caused by environmental factors such as sunlight and chemical and biological activity. Over the long term, however, definite increases in chlorophyll a would be indicative of accelerated enrichment (eutrophication) which could be induced by the addition of man generated nutrients.

Sources of nutrients are sink and laundry wastes and seepage from septic tank systems and pit privies. All lake users should be aware of the potential problems which can be caused by these sources of nutrients and that they can contribute to the impairment of recreational and aesthetic water quality. If, over the long term, it becomes apparent that man generated nutrients are contributing to accelerated eutrophication, then the sources would have to be identified and steps would have to be taken to minimize their effects.

This report includes a map or maps showing stations, weekly chlorophyll a and Secchi disc values, mean annual chlorophyll a and Secchi disc values and trophic state indices. The trophic state indices (0-100), developed by Carlson (1977), are derived from mean annual chlorophyll a and Secchi disc values.

NOTE: Water taken from lakes for domestic uses should be boiled or disinfected and, as is stated in the Public Health Act of Manitoba,

"All surface waters should be considered unsafe for domestic purposes unless boiled or otherwise disinfected..."

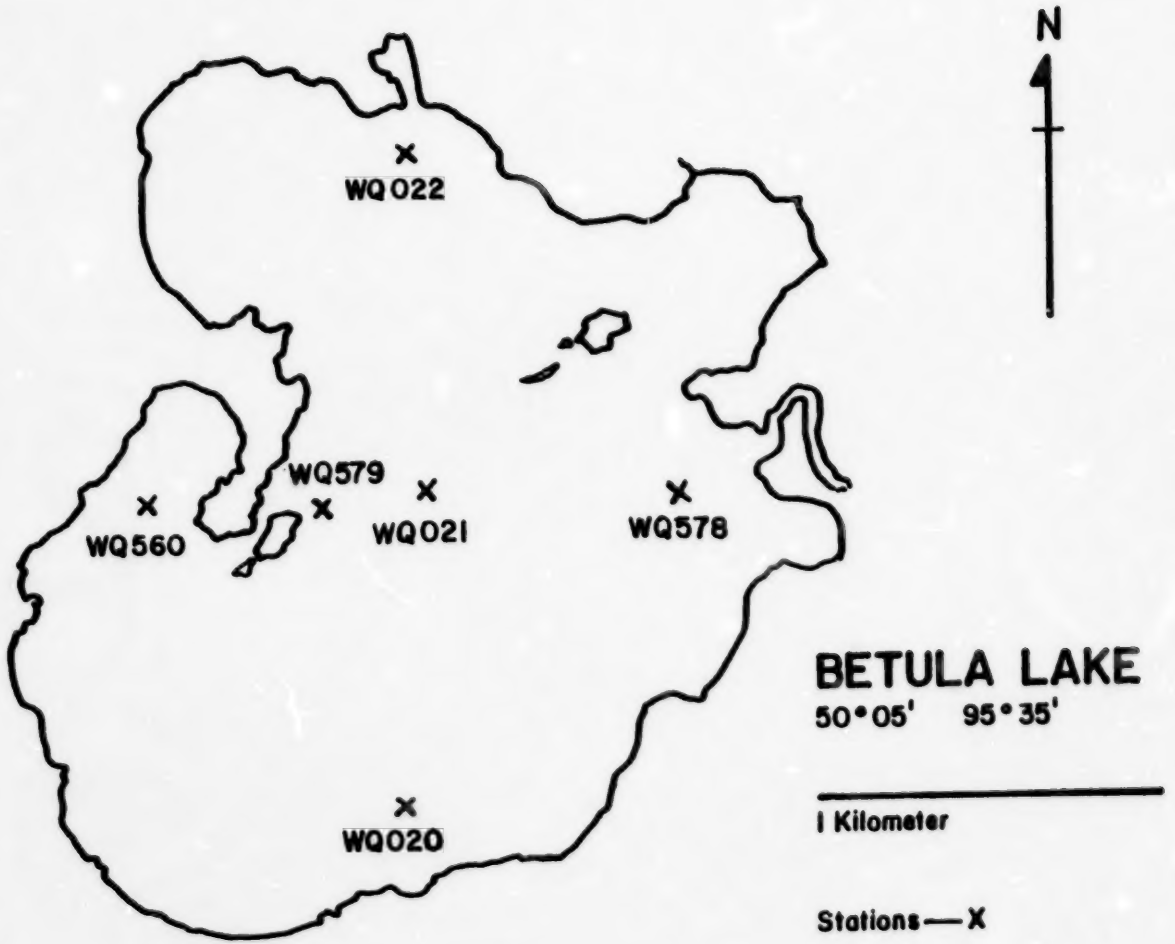

FIGURE 1: Betula Lake showing location of water quality stations

RESULTS AND DISCUSSION

Chlorophyll a and Secchi disc data were collected from various stations on Betula Lake (Figure 1). Chlorophyll a and Secchi disc results from stations WQ020, WQ021, WQ022, WQ560, WQ578 and WQ579 are presented for 1978 through 1982 in Table 1.

The mean annual chlorophyll a and Secchi disc results for each station sampled on Betula Lake and pther Whiteshell Lakes are shown in Table 2 (1978 through 1982). Mean overall annual chlorophyll a decreased from 22.3 to 8.5 ug/l from 1978 through 1981 and increased slightly to 10.9 ug/l in 1982. The 1981 and 1982 chlorophyll a results were indicative of moderately high algae levels but showed considerable improvement over the nuisance algae noted in the previous three years (Figure 2). Rooted aquatic weeds were not particularly abundant in 1982 and as a result did not affect boating activities to the extent which they have in the past. Mean overall annual Secchi disc values ranged from 0.9 to 1.5 m from 1978 to 1982.with the 1982 value of 1.5 m showing relatively good water transparency (Figure 2).

Carlson's (1977) trophic state indices (TSI) for chlorophyll a and Secchi disc have been noted for each station sampled in Betula Lake, in 1978 through 1981 (Table 4) and 1982 (Table 5). The TSIs value for chlorophyll a and Secchi disc ranged from 53.2 to 54.4 which would be indicative of a mesotrophic to eurotrophic or moderately enriched to enriched status. The TSI values from 1978 through 1981 ranged from 49.7 to 64.7 generally indicating a somewhat more enriched state than was noted in 1982. Subsequent data collection will more clearly delineate any permanent changes in trophic status.

Table 1. Chlorophyll a (Chlor a in ug/l) and Secchi disc (S.D. in m) values for Station WQ070, WQ071, WQ072, WQ578 and WQ579 in Betula Lake from 1978 through 1982.

Date	Station WQ070		Station WQ071		Station WQ072		Station WQ540		Station WQ578		Station WQ579	
	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Clor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D (m)
1978												
May 11	11.0	1.4	9.6	1.4	10.0	1.3						
May 18	12.0	1.2	7.5	1.0	8.5	1.3						
May 25	8.0	1.2	6.8	1.1	8.5	1.2						
June 8	9.4	1.2	9.9	1.3	9.1	1.2						
June 15	17.6	1.4	26.4	1.2	9.7	1.3						
June 22	12.5	1.1	13.8	1.1	12.9	1.0						
June 29	12.9	1.4	13.7	1.1	13.8	1.1	Not Sampled in 1978		Not Sampled in 1978		Not Sampled in 1978	
July 6	22.4	0.9	15.8	1.0	18.9	0.9						
July 13	23.8	0.8	22.8	0.9	22.4	0.8						
July 20	30.8	0.7	32.1	0.7	25.5	0.7						
July 27	31.2	0.6	35.0	0.5	30.9	0.5						
Aug. 3	29.6	0.6	28.3	0.6	32.5	0.6						
Aug. 10	19.5	0.5	28.0	0.5	29.0	0.6						
Aug. 17	39.6	0.5	45.6	0.5	58.5	0.5						
Aug 23	42.0	0.5	49.4	0.5	44.0	0.8						
1979												
May 15	12.5	1.7	15.8	1.7	16.2	1.7						
May 24	9.5	1.8	8.1	1.8	6.5	1.8						
May 31	7.0	1.9	9.8	2.2	9.1	2.0						
June 6	7.7	1.9	7.9	1.8	7.0	1.8						
June 13	10.5	1.0	18.5	1.0	11.3	0.8						
June 20	11.6	1.7	17.2	2.0	8.5	1.8						
June 28	10.5	1.8	8.9	1.5	11.4	1.8						
July 5	18.1	1.8	33.4	1.5	26.6	1.8	Not Sampled in 1979		Not Sampled in 1979		Not Sampled in 1979	
July 11	11.2	1.5	20.6	1.7	31.6	1.8						
July 18	26.9	1.2	17.8	1.2	24.6	1.3						
July 25	34.1	1.1	26.2	1.0	24.8	1.0						
Aug. 1	39.6	0.8	35.0	0.7	30.9	0.8						
Aug. 9	21.7	0.8	19.2	0.8	27.0	0.8						
Aug. 15	18.2	0.7	16.0	0.7	18.3	0.8						
Aug. 22	22.1	0.7	20.4	0.7	20.8	0.8						
Aug. 29	42.1	0.6	25.8	0.7	20.0	0.6						
1980												
May 21			18.4	1.5								
June 1			18.6	1.5								
June 9			30.0	2.0								
June 16			14.9	1.0								
June 29			10.5	1.0								
July 6	Not Sampled in 1980		9.0	1.0	Not Sampled in 1980		Not Sampled in 1980		Not Sampled in 1980		Not Sampled in 1980	
July 14			10.0	1.0								
July 21			13.0	2.0								
July 28			11.2	1.0								
Aug. 5			19.6	0.8								
Aug. 11			21.7	0.5								
Sept. 14			14.6	1.0								
1981												
May 29			-	-	8.1	2.0	-	-				
May 31			6.5	1.4	-	-	-	-				
June 7			28.3	1.2	-	-	-	-				
June 14			12.4	0.8	-	-	-	-				
June 28			7.0	0.8	-	-	-	-				
July 5			NA	0.8	-	-	NA	0.7				
July 12	Not Sampled in 1981		8.8	0.9	-	-	3.8	0.6	Not Sampled in 1981		Not Sampled in 1981	
July 19			5.3	1.0	-	-	-	-				
July 26			6.7	1.0	-	-	4.5	0.6				
Aug. 3			4.9	1.0	-	-	-	-				
Aug. 8			6.5	0.9	-	-	-	-				
Aug. 16			9.8	0.8	-	-	11.0	1.0				
Aug. 23			6.8	0.7	-	-	5.7	0.7				
Aug. 30			9.9	0.8	-	-	12.0	0.7				
Sept. 7			-	-	-	-	11.3	0.8				

Table 1 continued

Date	Station WQ020		Station WQ021		Station WQ022		Station WQ560		Station WQ578		Station WQ579	
	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Clor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)
1982												
May 12	13.4	1.5			16.6	1.5			13.1	1.8	12.6	1.5
May 19	5.5	1.8			8.5	1.8			6.2	1.6	4.0	1.8
May 26	8.8	1.6			10.6	1.6			8.8	1.6	11.1	1.7
June 2	9.0	1.8			9.2	1.7			7.2	1.6	8.5	1.8
June 9	6.0	1.8			8.0	1.8			8.8	1.3	11.1	1.6
June 16	7.8	1.8			8.1	1.7			6.2	1.8	9.0	1.7
June 23	7.6	1.8			2.9	1.7			4.8	1.8	4.1	1.8
July 7	16.8	1.6			18.0	1.6			21.0	1.5	20.5	1.7
July 14	11.0	1.8	Not Sampled		15.4	1.7	Not Sampled		8.2	1.7	13.3	1.7
July 21	10.9	1.5	in 1982		8.9	1.8	in 1982		6.5	1.9	10.7	1.8
July 28	8.8	1.3			7.7	1.3			7.8	1.3	9.2	1.5
Aug. 5	11.5	1.2			9.4	1.2			6.3	1.2	13.4	1.2
Aug. 11	14.1	1.1			12.7	1.0			11.7	1.1	11.5	1.0
Aug. 18	10.	1.3			9.9	1.3			8.6	1.4	12.	1.1
Aug. 25	9.1	1.3			13.	1.1			13.	1.3	11.	1.3
Sept. 9	14.	1.2			13.	1.3			13.	1.0	14.	1.2
Sept. 22	15.	1.3			14.	1.2			13.	1.3	13.	1.4
Oct. 6	12.	1.5			12.	1.5			13.	1.5	13.	1.4
Oct. 19	13.	1.5			15.	1.3			14.	1.3	12.	1.4
Nov. 3	13.	1.8			13.	1.6			9.3	1.5	13.	1.7

Table 2. Mean annual Chlorophyll a and Secchi disc values and trophic status index (TSI) for each station sampled on lakes in the Whiteshell Provincial Park, excluding lakes on the Winnipeg River, 1978 through 1980.

Lake	Station	1978				1979				1980			
		Chlorophyll a (ug/l)		Secchi Disc (m)		Chlorophyll a (ug/l)		Secchi Disc (m)		Chlorophyll a (ug/l)		Secchi Disc (m)	
		Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*
Barren	WQ577	--	--	--	--	--	--	--	--	--	--	--	--
Betula	WQ020	21.5	60.7	0.9	61.0	19.0	59.4	1.3	56.2	--	--	--	--
	WQ021	23.0	61.3	0.9	61.6	18.8	59.3	1.3	56.2	16.0	57.7	1.2	57.5
	WQ022	22.3	61.0	0.9	61.3	18.4	59.1	1.3	56.0	--	--	--	--
	WQ560	--	--	--	--	--	--	--	--	--	--	--	--
	WQ578	--	--	--	--	--	--	--	--	--	--	--	--
	WQ579	--	--	--	--	--	--	--	--	--	--	--	--
Brereton	WQ031	28.0	63.3	0.7	65.1	18.0	58.9	1.2	57.2	20.2	60.1	1.2	57.1
	WQ032	24.1	61.8	0.8	63.1	18.6	59.3	1.2	57.7	17.7	58.8	1.3	[illegible]6
	WQ033	24.1	61.8	0.8	62.6	18.0	58.9	1.2	56.9	19.7	59.8	1.3	[illegible]7
	WQ547	--	--	--	--	--	--	--	--	17.3	58.5	1.3	56.4
Caddy	WQ039	9.9	53.1	1.4	54.8	16.9	58.3	1.7	52.3	--	--	--	--
	WQ040	11.1	54.2	1.4	55.1	17.5	58.6	1.8	51.8	--	--	--	--
	WQ041	10.4	53.4	1.4	55.0	19.1	59.5	1.7	52.0	11.0	54.1	1.7	52.7
Falcon	WQ061	4.1	44.4	3.8	40.7	8.9	52.0	4.4	38.7	--	--	--	--
	WQ063	--	--	--	--	--	--	--	--	--	--	--	--
	WQ431	3.5	42.8	4.1	39.7	7.0	49.7	4.4	38.7	2.0	37.5	3.4	42.2
	WQ432	3.4	42.6	4.2	39.4	7.9	50.9	4.4	38.5	--	--	--	--
Florence	WQ580	--	--	--	--	--	--	--	--	--	--	--	--
Jessica	WQ065	10.5	53.7	1.3	56.3	15.9	57.7	1.5	54.4	6.6	49.1	1.8	51.4
	WQ066	11.4	54.4	1.3	56.6	14.8	57.0	1.5	54.3	6.3	48.6	1.8	51.8
	WQ067	15.0	57.1	1.2	57.5	15.2	57.3	1.3	56.6	7.7	50.5	1.6	53.1
Marion	WQ581	--	--	--	--	--	--	--	--	--	--	--	--
Red Rock	WQ144	9.7	52.9	2.0	49.9	14.2	57.0	2.2	48.4	20.4	60.1	2.0	50.1
	WQ145	10.3	53.4	1.9	50.9	13.4	56.0	2.1	49.2	--	--	--	--
	WQ146	9.1	52.3	1.7	52.7	14.4	56.7	2.0	49.9	--	--	--	--
Star	WQ173	--	--	--	--	12.3	55.2	2.2	48.4	--	--	--	--
	WQ174	--	--	--	--	11.7	54.7	2.2	48.6	7.0	49.6	2.4	47.4
	WQ175	--	--	--	--	13.0	55.7	2.2	48.3	--	--	--	--
	WQ582	--	--	--	--	--	--	--	--	--	--	--	--
West Hawk	WQ177	2.6	39.8	4.5	38.3	8.2	47.3	5.4	35.8	1.6	35.2	4.9	38.3
	WQ182	2.6	39.8	5.0	36.9	5.4	47.1	6.8	32.4	1.3	33.1	5.5	35.4
	WQ187	2.6	39.7	5.4	35.7	8.2	53.9	6.4	33.1	1.2	32.4	5.5	35.4
	WQ583	--	--	--	--	--	--	--	--	--	--	--	--
White	WQ188	13.0	55.7	1.1	58.9	18.3	59.1	1.3	56.2	9.9	53.0	1.6	53.6
	WQ189	14.8	57.0	1.1	59.0	16.9	58.3	1.4	55.2	9.9	53.0	1.6	53.0
	WQ190	14.5	56.8	1.1	59.2	22.1	60.9	1.3	56.2	10.2	53.4	1.7	52.6
Whiteshell	WQ202	18.7	59.3	1.6	53.0	19.1	59.5	2.6	46.3	19.2	59.5	1.7	52.4
Big	WQ433	19.1	59.5	1.6	53.6	19.9	59.9	2.7	46.0	20.3	60.1	1.6	53.7
	WQ434	18.9	59.3	1.5	54.2	21.3	60.6	2.4	47.5	20.1	60.0	1.5	54.2

* Carlson's (1977) Trophic State Index.
a Less than 5 Samples Taken.

Table 2. Continued

Lake	Station	1981 Chlorophyll a (ug/l) Mean	1981 Chlorophyll a (ug/l) TSI*	1981 Secchi Disc (m) Mean	1981 Secchi Disc (m) TSI*	1982 Chlorophyll a (ug/l) Mean	1982 Chlorophyll a (ug/l) TSI*	1982 Secchi Disc (m) Mean	1982 Secchi Disc (m) TSI*
Barren	WQ577	29.6	63.8	0.8	56.8	---	--	--	--
Betula	WQ020	7.0	49.7	0.7	64.7	10.9	54.0	1.5	53.9
	WQ021	9.4	52.6	1.0	60.3	--	--	--	--
	WQ022	8.1[a]	51.1[a]	2.0[a]	50.0[a]	11.3	54.4	1.5	54.3
	WQ560	8.1	51.0	0.7	64.6	--	--	--	--
	WQ578	--	--	--	--	10.0	53.2	1.5	54.4
	WQ579	--	--	--	--	11.4	54.4	1.5	54.0
Brereton	WQ031	8.1	51.1	1.0	60.1	3.3	42.2	1.3	55.8
	WQ032	11.3	54.3	1.3	55.8	7.5	50.4	1.1	58.0
	WQ033	11.5	54.5	1.4	55.3	8.5	51.6	1.2	57.1
	WQ547	--	--	--	--	--	--	--	--
Caddy	WQ039	4.8	46.0	2.2	48.9	6.5	49.0	1.6	53.1
	WQ040	5.2	46.6	1.7	52.5	6.6	49.1	1.5	53.9
	WQ041	5.1	46.5	1.9	51.0	6.0	48.2	1.5	54.6
Falcon	WQ061	2.7	39.6	3.8	40.7	3.0	41.2	4.5	38.4
	WQ063	--	--	--	--	2.7	40.2	3.8	40.7
	WQ431	2.7	40.3	3.8	40.7	2.6	39.8	3.6	41.4
	WQ432	--	--	--	--	--	--	--	--
Florence	WQ580	2.8	40.6	2.6	46.2	2.9[a]	41.0[a]	2.6[a]	46.5[a]
Jessica	WQ065	7.1	49.8	1.2	57.3	10.4	53.5	1.0	60.7
	WQ066	6.6	49.0	1.3	56.6	9.0	52.1	1.0	60.5
	WQ067	23.4	61.5	1.6	53.6	9.6	52.8	0.9	60.9
Marion	WQ581	20[a]	37.1[a]	4.9[a]	37.2[a]	1.8[a]	36.3[a]	3.5[a]	42.1[a]
Red Rock	WQ144	12.4	55.3	2.2	48.4	5.8	47.8	2.4	47.5
	WQ145	4.7	45.8	1.9	50.8	4.9	46.2	2.1	49.6
	WQ146	--	--	--	--	--	--	--	--
Star	WQ173	4.7	45.8	2.6	46.1	5.3	46.9	1.9	50.9
	WQ174	4.5	45.3	2.6	46.3	5.6	47.5	1.7	52.0
	WQ175	4.3	44.8	2.6	46.3	5.9	48.0	1.7	52.2
	WQ582	--	--	--	--	5.3	46.9	1.8	51.8
West Hawk	WQ177	2.2	38.2	3.9	40.4	1.6	35.2	3.7	41.3
	WQ182	2.0	37.4	5.3	36.0	1.3	33.4	4.9	37.1
	WQ187	2.1	38.0	4.9	37.0	1.5	34.8	4.5	38.3
	WQ583	--	--	--	--	1.8[a]	36.5[a]	4.8[a]	37.3[a]
White	WQ188	--	--	--	--	4.9[a]	45.5	1.0[a]	60.0[a]
	WQ189	8.2	51.3	1.3	56.4	11.4	54.5	1.2	56.9
	WQ190	8.0	50.9	1.4	55.0	--	--	--	--
Whiteshell	WQ202	22.6	61.2	1.7	52.2	25.4[a]	62.3[a]	1.3[a]	56.6[a]
Big	WQ433	20.1	60.0	1.7	52.3	23.9	61.7	1.2	56.9
	WQ434	15.8	57.6	1.6	52.9	23.9	61.7	1.0	60.7

* Carlson's (1977) Trophic State Index.
a Less than 5 Samples Taken.

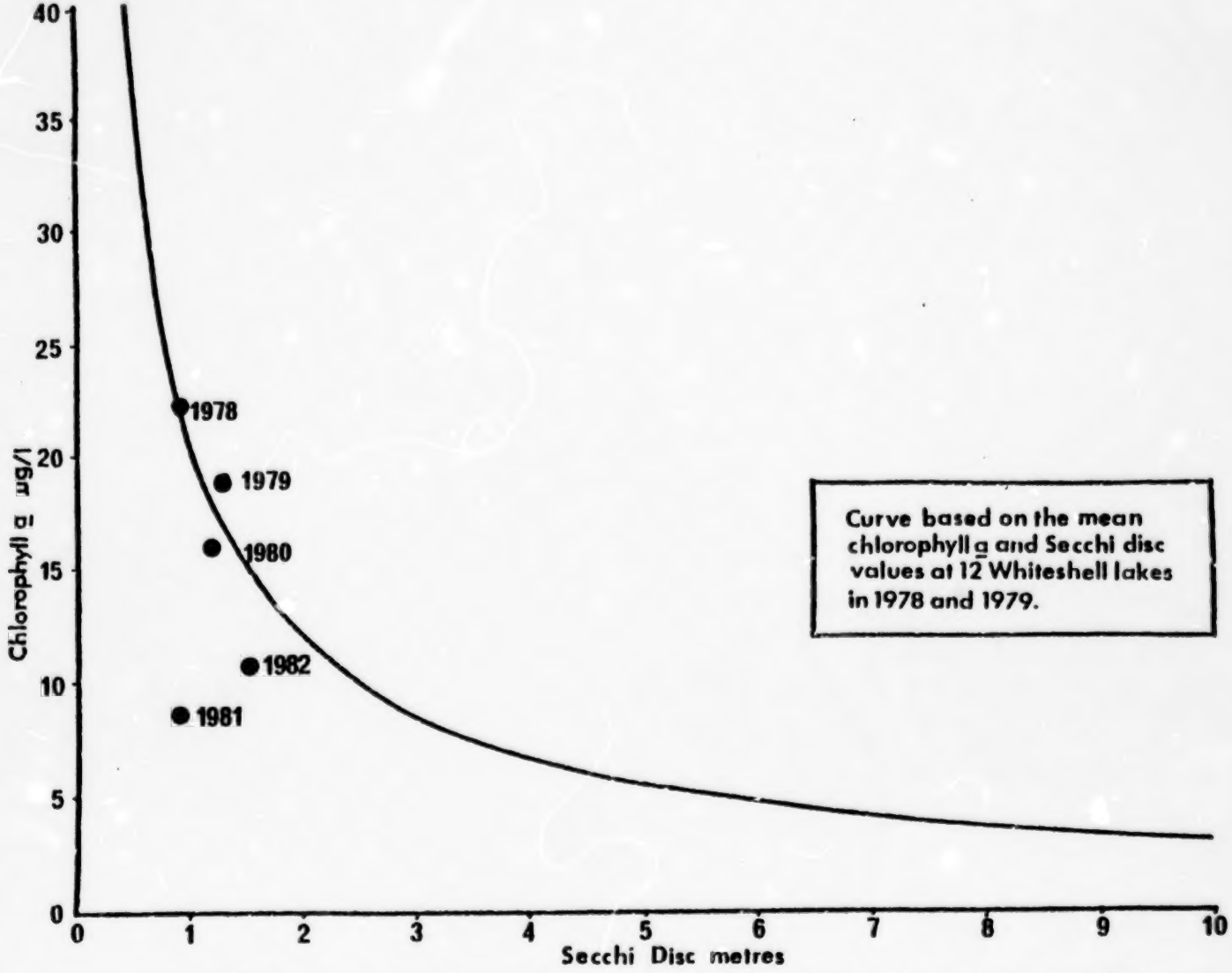

FIGURE 2. The mean chlorophyll a and Secchi disc values collected on Betula Lake

GLOSSARY OF TERMS

ALGAE - an assemblage of simple, mostly microscopic non-vascular plants containing photosynthetic pigments such as chlorophyll. Algae occur suspended in water (phytoplankton) and attached to rock and other suitable substrates. Some algae may produce nuisance conditions when environmental parameters are suitable for prolific growth.

CHLOROPHYLL - the photosynthetic green pigment which occurs in all groups of algae.

EUPHOTIC ZONE - the lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur due to insufficient light penetration.

EUTROPHIC - waters containing a rich supply of plant nutrients that support heavy growths of algae and aquatic plants. The increase in algae causes a decrease in the penetration of light. Deep areas may exhibit oxygen depletion due to the decomposition of dead organisms. Eutrophic lakes tend to be shallow and support warm water species of fish. The degradation in water quality renders the lake unsuitable for many recreational activities.

EUTROPHICATION - the process of becoming increasingly enriched in nutrients. It refers to the entire complex of changes which accompanies increasing nutrient enrichment. The result is the production of dense nuisance growths of algae and aquatic weeds which generally degrade water quality and render the lake unsuitable for many recreational activities. Accompanying the increase in algae is a decrease in game fish and an increase in coarse fish.

MESOTROPHIC - waters characterized by a moderate nutrient supply and organic production (i.e. midway between eutrophic and oligotrophic). The waters are suitable for most recreational activities.

OLIGOTROPHIC - waters containing a poor supply of plant nutrients resulting in little algae and aquatic plant growth. The waters are generally clear permitting extensive light penetration. Oxygen in the bottom waters is abundant. Oligotrophic lakes tend to be deep and support cold water fish such as lake trout and whitefish. The lakes are well suited for all types of recreational activities.

SECCHI DISC - a circular metal plate, 20 centimeters in diameter, the upper surface of which is divided into four equal quadrants and so painted that two quadrants directly opposite each other are painted black and the intervening ones white. The Secchi disc is used to estimate the depth of the euphotic zone.

TROPHIC STATUS - depending upon the degree of nutrient enrichment and resulting biological productivity, lakes are generally classified into three intergrading types: oligotrophic, mesotrophic and eutrophic. If the supply of nutrients to an oligotrophic lake is progessively increased, the lakes becomes more mesotrophic in character; with continued enrichment, it will become eutrophic.

µg/l - micrograms per liter or parts per billion.

LITERATURE CITED

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POOR

QUALITY

ORIGINAL